MAINTENANCE MANAGEMENT OF THE MAIN ROADS IN BANGLADESH

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SYNOPSYS

The Roads and Highways Department (RHD) of Bangladesh is responsible for the management of the main road network of 7,500 Km of national and regional highways and 13,250 Km of district roads; of which 20% is unpaved. RHD utilizes a comprehensive system called Road Asset Management System (RAMS) for effective management of such huge network. RAMS guides through an annual cycle of activities resulting in GIS-based maps indicating recommended treatment types prioritized at two levels. Activities include annual measurement of road roughness, road condition and traffic flows; followed by economic evaluation of treatment alternatives using Highway Development and Management (HDM-4) model. Outcome of these activities and analyses are compiled in the Annual Road Maintenance Needs Report which also presents budgetary implications of different alternative scenario.

Road Maintenance in Bangladesh is constrained by its socio-economic and climatic conditions. Thrust on economic growth of the country results in faster growth in traffic on the roads and hence accelerated reduction in pavement life time. Heavy rainfall in the monsoon and regular flooding not only damage pavements and road embankments; but also reduce the construction season to six or even seven months in a year. Funding limitations along with other adversities drive RHD to be critically selective in deciding its road management programme.

This paper outlines road maintenance systems used in Bangladesh; and later, discusses the specific challenges faced by RHD in managing the main road network.

1.0 INTRODUCTION

The Roads and Highways Department (RHD) is a government organization with responsibility of development and management of national, regional and district road network of the country. Total network of roads is shown in Table 1.

Table 1: RHD Road Network

Road Type	Total Length (km)	Paved Road (km)	Unpaved Road (km)	Paved Roads (km)
National Highways	3,476	3,363	113	97%
Regional Highways	4,164	3,936	228	94%
Zilla Roads	13,253	10,258	2,995	77%
Total	**20,893**	**17,557**	**3,336**	**84%**

From the fiscal year 2005-06 maintenance programme, RHD introduced a new comprehensive system Road Asset Management System (RAMS) which brought together RHD's all databases and analytical procedures. The final output of RAMS is the RAMS Map: a single GIS-based map for each Road Division showing combination of all relevant information to the decision makers where they can most effectively allocate funds for maintenance and rehabilitation.

The strength of the RAMS Map is its simplicity. It presents information in a highly visual graphical format using a minimal set of symbols and colours. RAMS relies on output from the Road

Maintenance and Management System (RMMS), Bridge Maintenance Management System (BMMS) and Highway Development and Management (HDM-4) Model. RHD has been using the HDM-4 for asset maintenance management system as a tool for economic analysis since financial year 1999-2000. The quality of the RAMS Output is therefore substantially dependent on the quality of the data included in these databases.

2.0 CURRENT CONDITION OF ROAD NETWORK

Each year RHD carries out roughness surveys to provide the critical input to HDM. Survey data of 2007-08 has been utilized in this analysis to forecast current road situation using Road Deterioration Models of HDM-4. The total lengths of road surveyed are as shown in Table 2.

Table 2: 2007-08 Survey Information

Road Class	Road Condition Survey Length (km)	Traffic Count Stations (Nos.)	Deflection Measuring Locations (Nos.)	Roughness Survey Length (km)
National Highways	3,401	161	1,730	3,379
Regional Highways	3,840	161	1,212	3,262
Zilla Road	7,246	403	-	4,851
Total	**14,487**	**726**	**2,942**	**11,492**

The Road Measurement and Data Acquisition System (ROMDAS) was used to obtain roughness data. Around 65% of paved roads were covered by the roughness surveys carried out in early 2008. Figure 1 compares the average roughness of RHD network for last 4 years.

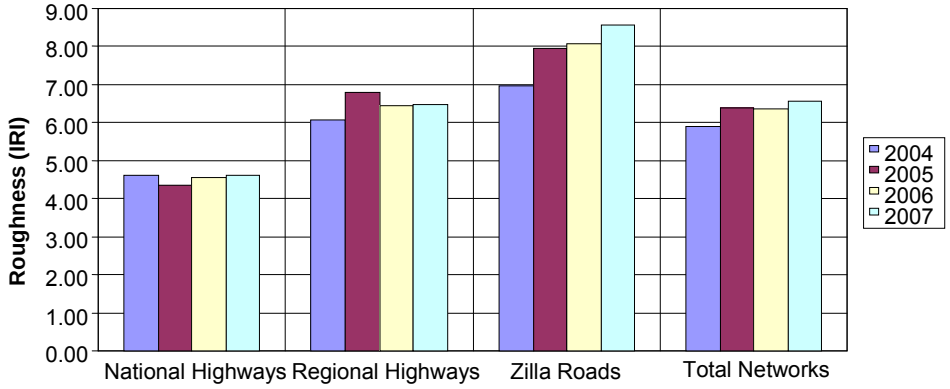

Figure 1: Average network roughness by road classes for the last 4 years

It is found that average roughness for National network has increased from 4.55 to 4.62, Regional network from 6.44 to 6.47 and Zilla network from 8.08 to 8.55 in 2006-07 to 2007-08.

These road networks may be categorised into descriptive bands based on their roughness as shown in Table 3. Different ranges are adopted for each road class to reflect their relative importance and expected level of service from each road class.

Table 3: Qualitative Descriptors of IRI Values

Category	National Highway	Regional Highway	Zilla Road
	IRI Values		
Good	0 – 3.9	0 – 4.9	0 – 5.9
Fair	4.0 – 5.9	5.0 – 6.9	6.0 – 7.9
Poor	6.0 – 7.9	7.0 – 8.9	8.0 – 9.9
Bad	8.0 – 9.9	9.0 – 10.9	10.0 – 11.9
Very Bad	≥10.0	≥11.0	≥12.0

Figures 3 to 5 in the following page show network condition by Zone and road class depicting the present condition of RHD road networks based on the categories shown above.

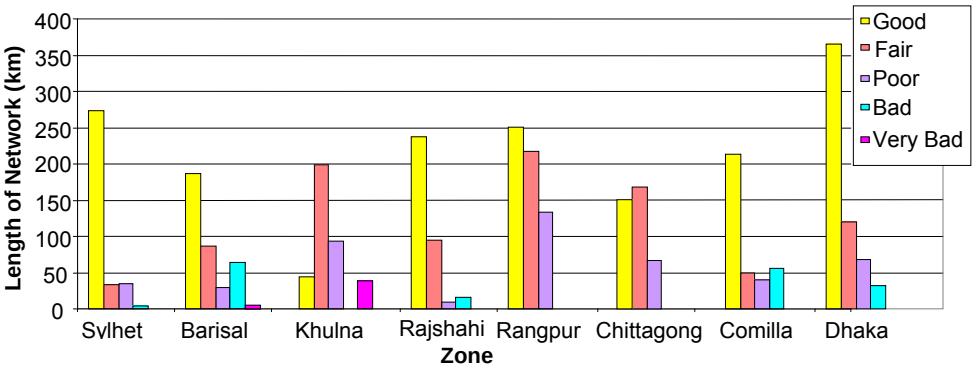

Figure 3: Road condition of National Highways based on IRI values (Survey: 2007-08)

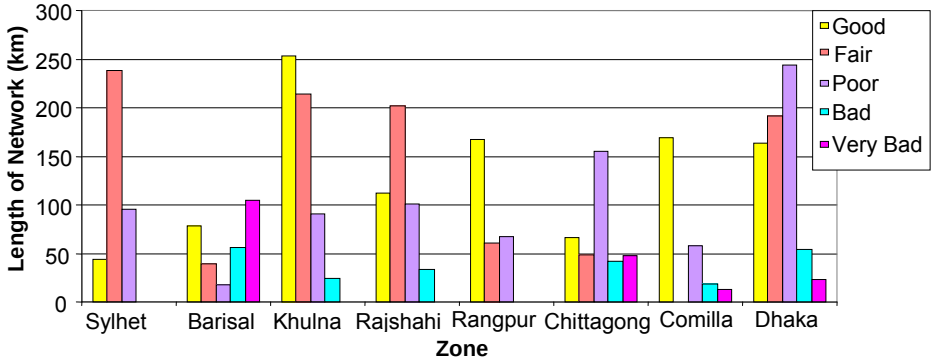

Figure 4: Road condition of Regional Highways based on IRI values (Survey: 2007-08)

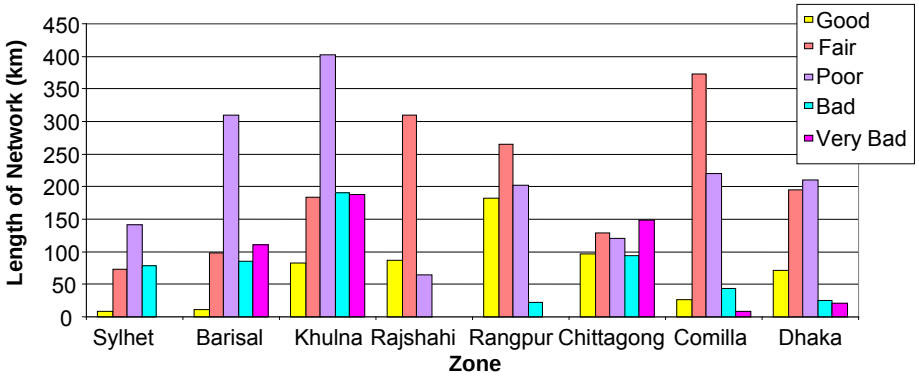

Figure 5: Road condition of Zilla Road based on IRI values (Survey: 2007-08)

3.0 THE COST OF NOT MAINTAINING ROADS

Road maintenance programmes have mostly been under invested over the years. Table 4 in the following page shows the progressive devaluation of RHD road assets based on data from previous years' Maintenance Needs Reports (MNRs).

Table 4: The Cost of Not Maintaining Roads (million Taka)

Year	Actual Value	As New value	% value	Daily Depreciation
2004 – 05	211,010	239,970	88%	Allowing for variations in analysis methods, approximately **20 million Taka/day** over 3 years.
2005 – 06	Not calculated (Data not available)			
2006 – 07	215,600	252,260	85%	
2007 - 08	254,710	315,220	81%	

The negative trend is clear over the period and the pattern continued with increases in the lengths of road requiring periodic maintenance and rehabilitation.

4.0 HDM ANALYSIS

The current Maintenance and Rehabilitation Needs Assessment of 2008-09 for RHD for paved roads has been done based on the outputs from the HDM-4 Model. The lengths of roads included in HDM-4 analysis are shown in Table 5. This year's analysis has been carried out on about 16,924 km of paved road of National, Regional and Zilla (District) roads. Ongoing projects, which are in progress and not completed before the start of Roughness survey, have been excluded from the HDM run.

Table 5: Lengths of roads included in the HDM analysis

Network Category	Analyzed length (km) for All Roads	Analyzed length (km) Excluding ongoing projects
National Highways	3,031	2,006
Regional Highways	3,775	2,768
Zilla Roads	10,118	7,000
Total	**16,924**	**11,774**

The purpose of this exercise is to develop a 5-year investment plan to provision for acceptable levels of service of the network. The outputs from HDM-4 are based on RMMS. The Assessment also provides recommendations for Managers and Engineers in RHD to improve the road network in a cost effective manner. It should be noted that this Maintenance Needs Report deals only with the needs of roads and road pavements and does not address needs for bridges and structures.

4.1 Strategy of HDM-4 Analysis

The analysis was carried out in the following sequence:

- Run all roads in the network to give unconstrained results. This will allow comparison with previous years' results to get a picture of overall changes in network condition and provide a basis for the five-year investment plan.
- Remove all segments which have ongoing projects and run to give unconstrained results. This provides a figure for immediate network needs for 2008-09.

4.2 Life Cycle Analysis and Description of Treatments

The life cycle analysis in HDM-4 predicts the pavement conditions (performance), the required treatments and costs and benefits over a specified period (in this case 20 years) under two scenarios are compared a) "Do Minimum" or "Holding treatment", and b) "With Maintenance". The costs used in this analysis include cost of capital investment, maintenance costs and vehicle operating costs at a 12% discount rate for calculation of Net Present Value (NPV). The HDM analysis considers a number of treatments representing the most commonly used types of maintenance work items in Bangladesh. Table 6 provides details of these treatments and the assumptions made for HDM.

Table 6: Maintenance and rehabilitation treatments and assumptions used in HDM

Routine Maintenance	
Off-pavement works	Includes all regular works along a road such as maintaining shoulders, roadside vegetation control, cleaning side drains and pipe culverts, maintenance of signs and signals.
Patching	Repair of potholes based on a standard pothole unit of $0.01m^3$ per pothole. The quantity of pothole repairing shall not be more than 1% of the total surface.
Crack Sealing	Sealing to cracks using Seal Coat/Fog Seal. It assumes a maximum in any one kilometre of 5% area affected.

Periodic Maintenance	
Preparatory Patching	Patching potholes and regulating surface irregularities prior to undertaking the treatments like DBST or DBS Overlay. Should not be more than 2% of the total quantity of overlay for National roads and maximum of 5% for Regional roads.
Preparatory Edge Repair	Allows for restoring pavement edges that have been damaged by vehicles leaving the road to drive onto the shoulder prior to undertaking the treatments like DBST or DBS Overlay.
DBST	Applying two layers of surface treatments on the prepared road surface. The total thickness has been specified as 25mm. This is applied in medium to highly trafficked road. Life expectancy assumed to be 3 years.
Bituminous Carpeting	This is a 40 mm thick manual overlay used in low trafficked roads in place of dense bituminous overlay. Life expectancy has been taken as 2 to 4 years.
Overlay	Machine laid premixed dense bituminous surfacing overlay 50 – 80 mm thick used in medium to highly trafficked roads. Carefully controlled overlay may be applied in response to badly damaged road surface or high roughness so as to obtain a predefined roughness level (2.5 to 3 IRI). Life expectancy assumed to be 5 years.
Rehabilitation	
Partial Reconstruction	Reconstruction of the upper pavement layers following scarification of the existing damaged surface and re-compaction. Normally a 150-200 mm crushed aggregate base with a dense bituminous surfacing of between 75 and 195mm, depending on traffic level. This is a treatment to overcome higher roughness or higher levels of surface cracking resulting from delayed maintenance. Life expectancy should be 10 years prior to major periodic maintenance. Full design of the pavement must be undertaken prior to treatment. Shoulder rehabilitation would also be provided where necessary.
Complete Reconstruction	A major reconstruction on the existing alignment and within the same overall dimension limits. The road is not widened. The pavement must be fully designed prior to construction and shoulder rehabilitation provided where necessary. Life expectancy should be 10 years before major periodic maintenance. Applied where there are extremely high levels of roughness and extensive cracking.
Holding Treatment	
	DBST triggered when rehabilitation is required but budget constraints do not permit the preferred treatment. Expected to last for 3 years

4.3 Maintenance Strategy

Table 7 shows the compound maintenance standards adopted for HDM analysis for the different classes of roads. These standards are based on experience and analysis of road conditions in Bangladesh, and are considered to be a reliable basis for HDM-4 to estimate economic performance of the network. Final treatment designs must be separately established.

Compound maintenance standards have been modified slightly, but are similar to the previous years' standards. The slight modification relates to the thicknesses of surfacing for partial reconstruction and full reconstruction based on traffic loads. Corridor roads (N1, N2, N3, N4, N5, N6, N7 and N8) were given high priority and hence they were analysed separately as they cover the major traffic and will be the part of the Asian Highway Network in the near future. Hence, periodic maintenance was considered at 4 IRI.

The other National highways, Regional highways and Zilla roads were considered for periodic maintenance at 5, 5.5 and 6 IRI respectively. "Holding maintenance strategy" was considered to maintain roads using DBST when funding is limited and higher treatments cannot be provided. Application of DBST can then delay further road deterioration.

Table 7: Compound maintenance standards for HDM-4 programme analysis in 2008-09

a) Holding Standard with Reconstruction for National and Regional Roads						
IRI Range	**All Damage (%)**	**Traffic Range (MT-AADT)**				
		100 – 1999	**2000 - 3999**	**4000 - 5999**	**6000 - 9999**	**> 10000**
<12.0	<5%	Routine	Routine	Routine	Routine	Routine
	5 - 10%	Routine	Routine	Routine	DBST 25mm	DBST 25mm
	10 - 20%	Routine	Routine	DBST 25mm	DBST 25mm	DBST 25mm
	20 - 30%	Routine	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm
	> 30%	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm
>12.0	All	Full Rec 110mm	Full Rec 135mm	Full Rec 150mm	Full Rec 180mm	Full Rec 195mm
b) Holding Standard with Reconstruction for Zilla Roads						
IRI Range	**All Damage (%)**	**Traffic Range (MT-AADT)**				
		100 – 999	**1000-1999**	**2000-2999**	**3000-3999**	**>4000**
<12.0	0 -10%	Routine	Routine	Routine	Routine	Routine
	10-20%	Routine	Routine	Carpet 40mm	Carpet 40mm	Carpet 40mm
	20-30%	Routine	Carpet 40mm	Carpet 40mm	Carpet 40mm	Carpet 40mm
	>30%	Carpet 40mm	Carpet 40mm	Carpet 40mm	Carpet 40mm	Carpet 40mm
>12.0	All	Full Rec 75mm	Full Rec 75mm	Full Rec 75mm	Full Rec 75mm	Full Rec 75mm
c) Compound Maintenance Standards for National Corridor Roads						
IRI Range	**Cracking Range (%)**	**Traffic Range (MT-AADT)**				
		100 - 1999	**2000 - 3999**	**4000 - 5999**	**6000 - 9999**	**> 10000**
<4.0	< 25%	Routine	Routine	Routine	Routine	Routine
	>= 25%	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm	Overlay 50mm
4.0–<7.0	All	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 80mm
7.0-<9.0	All	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 60mm	Overlay 80mm
9.0-<12.0	All	Rehab 120mm	Rehab 140mm	Rehab 150mm	Rehab 180	Rehab 195mm
>12.0	All	Full Rec 120mm	Full Rec 140mm	Full Recon 150mm	Full Rec 180mm	Full Rec 195mm
d) Compound Maintenance Standards for Other National Roads						
IRI Range	**Cracking Range (%)**	**Traffic Range (MT-AADT)**				
		100 - 1999	**2000 - 3999**	**4000 - 5999**	**6000 - 9999**	**> 10000**
< 5.0	< 25%	Routine	Routine	Routine	Routine	Routine
	>= 25%	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm	Overlay 50mm
5.0-<7.0	All	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 80mm
7.0-<9.0	All	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 60mm	Overlay 80mm
9.0-<12.0	All	Rehab 110mm	Rehab 135mm	Rehab 150mm	Rehab 180 mm	Rehab 195mm
>12.0	All	Full Rec 110mm	Full Rec 135mm	Full Rec 150mm	Full Rec 180mm	Full Rec 195mm

4.4 Field Validation of Results

This year HDM outputs were sent to Field offices to investigate whether they reflect the field conditions. It was observed that field officers agree with HDM outputs in most of the cases. Table 8 shows a selection of the results of HDM and the field officers comments:

Table 8: Comparisons between HDM-4 outputs and field responses

e) Compound Maintenance Standards for Regional Roads

IRI Range	Cracking Range (%)	Traffic Range (MT-AADT)				
		100 - 1999	2000 - 2999	3000 - 3999	4000 - 4999	> 5000
< 5.5	< 25%	Routine	Routine	Routine	Routine	Routine
	>= 25%	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm	DBST 25mm
5.50-<7.0	All	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 60mm
7.0-<9.0	All	Overlay 50mm	Overlay 50mm	Overlay 50mm	Overlay 60mm	Overlay 60mm
9.0-<12.0	All	Rehab 110mm	Rehab 135mm	Rehab 135mm	Rehab 150 mm	Rehab 150 mm
>12.0	All	Full Rec 110mm	Full Rec 135mm	Full Rec 135mm	Full Rec 150mm	Full Rec 150mm

f) Compound Maintenance Standards for Zilla Roads

IRI Range	Cracking Range (%)	Traffic Range (MT-AADT)				
		100-999	1000-1999	2000-2999	3000-3999	>4000
<6.0	< 25%	Routine	Routine	Routine	Routine	Routine
	>= 25%	Seal 15mm	Seal 15mm	Seal 15mm	Carpet 40mm	Overlay 50mm
6.0-<7.0	All	Carpet 40mm	Carpet 40mm	Carpet 40mm	Carpet 40mm	Overlay 50mm
7.0-<9.0	All	Carpet 40mm	Carpet 40mm	Carpet 40mm	Carpet 40mm	Overlay 50mm
9.0-<12.0	All	Rehab-75mm	Rehab-75mm	Rehab-75mm	Rehab- 75mm	Rehab-75mm
>12.0	All	Full Rec 75mm	Full Rec 75mm	Full Rec 75mm	Full Rec 75mm	Full Rec 75mm

Road No	Chainage (km)	HDM Results	Comments of the field officers
N102	040.00-043.30	Overlay 50mm	Base of the road is in good condition. Overlay is the best solution.
N102	044.00-053.20	Rehab 180mm	Due to improper pavement thickness rehabilitation work is needed.
N102	056.04-056.07	Full Recon 180mm	Pavement is damaged. Full reconstruction is needed.
N102	057.94-059.04	DBST	Rehabilitation is needed with raising of pavement.
N102	060.94-064.34	Rehab 135mm	In this pavement section, the thickness of ISG & Sub-base is not sufficient for national highways. So, Rehabilitation is needed.
N102	077.00-082.20	Rehab 180mm	Due to improper pavement thickness rehabilitation work is needed.
N102	082.20-82.33	Overlay 50mm	Pavement in good condition. But surfacing work is needed.
N8	122.76-162.51	Overlay 50mm	Km115.00-139.00 DBST is needed. Km 139.00-149.00 50mm overlay is needed and km 149.00-161.70 DBST is enough.
N8	162.51-168.10	Overlay 50mm	It is ok.
N8	(173.45-177.24) &	Overlay 50mm &	Section km173.80-188.660 is undulated. So this should be strengthened by 50mm overlay.

Road No	Chainage (km)	HDM Results	Comments of the field officers
	(177.24-177.30)	Rehab 120mm	
R870	051.90-053.64	DBST	DBST 25mm to seal minor cracks is required.
R870	054.04-064.24	Full recon 110mm	Full recon 110mm is required due to undulation of pavement.

5.0 NETWORK RESULTS (UNCONSTRAINED)

HDM-4 analysis was carried out for all road networks to get the overall picture of needs. This has produced a detailed work programme for the full 20-years analysis period. However, only the first five years should be considered when estimating the future funding needs due to the uncertainty about future conditions and availability of funds.

The unconstrained capital cost and average cost of initial 5 years for all analysed road lengths are given in the figure 6 below. Here, the total five years cost for capital works; i.e. periodic maintenance, partial and full reconstruction, is 81,186 million taka whereas the average demand per year is 16,237 million taka.

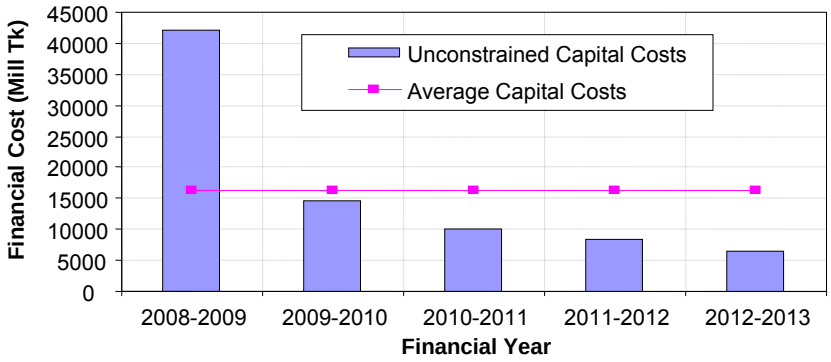

Figure 6: Unconstrained and average demand of capital works for the next five years

In connection with above figure, Tables 9 to 13 show the class wise demand required for the first five years of analysis.

Table 9: Total capital works demands (million Tk) for the next five years

Road Type	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Total
National	10,834	4,712	2,487	1,842	606	20,482
Regional	10,139	1,998	1,762	1,104	780	15,783
Zilla	21,085	7,846	5,692	5,320	4,977	44,921
Total	**42,059**	**14,556**	**9,941**	**8,267**	**6,363**	**81,186**

Table 10: Periodic maintenance demand (million Tk) for the next five year

Road Type	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Total
National	6,134	2,933	1,295	587	606	11,555
Regional	5,005	1,067	1,572	818	762	9,223
Zilla	2,603	864	792	1,564	1,736	7,559
Total	**13,741**	**4,864**	**3,659**	**2,969**	**3,104**	**28,337**

Table 11: Partial reconstruction demand (million Tk) for the next five year

Road Type	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Total
National	3,310	1,595	1,169	1,256	0	7,329
Regional	2,716	683	130	5	12	3,547
Zilla	11,599	6,383	4,779	3,480	2,675	28,915
Total	**17,625**	**8,661**	**6,077**	**4,741**	**2,687**	**39,791**

Table 12: Full reconstruction demand (million Tk) for the next five year

Road Type	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Total
National	1,391	184	23	0	0	1,598
Regional	2,418	274	60	281	6	3,040
Zilla	6,884	599	121	276	566	8,447
Total	**10,692**	**1,058**	**205**	**558**	**572**	**13,084**

Table 13: Routine maintenance demand (million Tk) for the next five year

Road Type	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Total
National	177	191	203	215	218	1,005
Regional	244	392	403	420	425	1,884
Zilla	546	900	975	1,051	1,111	4,581
Total	**967**	**1,483**	**1,581**	**1,686**	**1,754**	**7,471**

Figure 7 gives a comparison of this year analysis with the previous year with respect to demand per km of analyzed length. Analysed length for 2008-09 analysis is 16,924 km against 15,822 km in 2007-08 analysis. Both sets of figures are from analyses including ongoing projects.

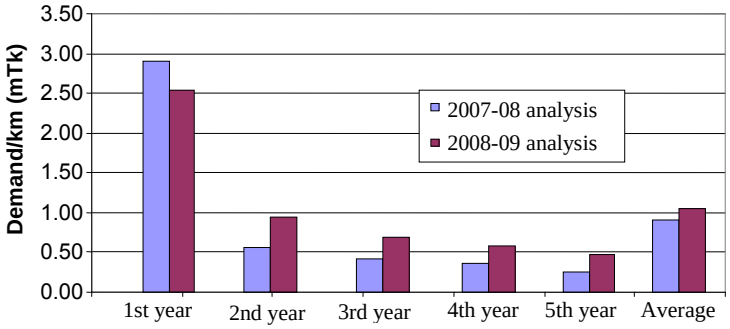

Figure 7: Comparison of demand per km of analysed length between 2007-08 and 2008-09.

5.1 Demand Excluding Ongoing Projects

Efforts were made to identify "ongoing" projects (comprising ongoing and already planned projects) that were not completed before the start of roughness survey. HDM analysis was done excluding the "ongoing" projects to avoid the duplication in the current year's maintenance programme and to find out actual needs of the networks.

In the following page, Table 14 separately show the needs of the National and Regional Road networks and the Zilla road network respectively, after removal of ongoing projects. It would be clear from the Figures 8 and 9 in the same page that rehabilitation (partial and full reconstruction) demand for Zilla roads is significantly higher than for periodic maintenance. This further strengthens the case for immediate implementation of the "Zilla Roads Recovery Plan" as detailed in the Road Master Plan.

Table 14: Funding needs of National & Regional networks and capital works of Zilla roads networks for 2008-09 (excluding ongoing projects) in Million Taka

	National & Regional Road Networks				Zilla Roads Networks			
Zone	**Periodic Maint.**	**Partial Reconst**	**Full Reconst.**	**Total**	**Periodic Maint.**	**Partial Reconst**	**Full Reconst.**	**Total**
Barisal	851	837	1,144	2,831	145	694	1,038	1,877
Chittagong	595	298	219	1,111	153	914	526	1,593
Comilla	694	520	221	1,435	147	1,057	196	1,400
Dhaka	1,643	890	332	2,865	111	2,204	294	2,609
Khulna	986	362	175	1,524	229	1,193	979	2,402
Rajshahi	1,158	390	61	1,609	589	695	282	1,565
Rangpur	563	204	118	885	668	722	286	1,677
Sylhet	52	309	84	1,245	62	544	26	632
Total	**7,343**	**3,810**	**2,352**	**13,505**	**2,106**	**8,023**	**3,627**	**13,755**

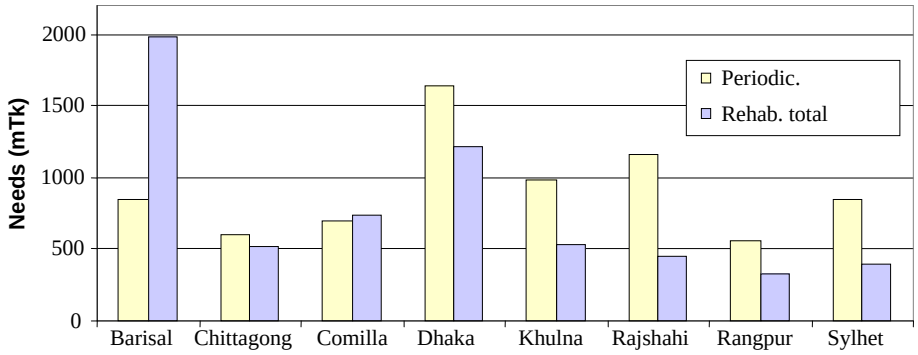

Figure 8: Zone wise capital needs of National and Regional Highways for 2008-09 in Million Taka (excluding ongoing projects)

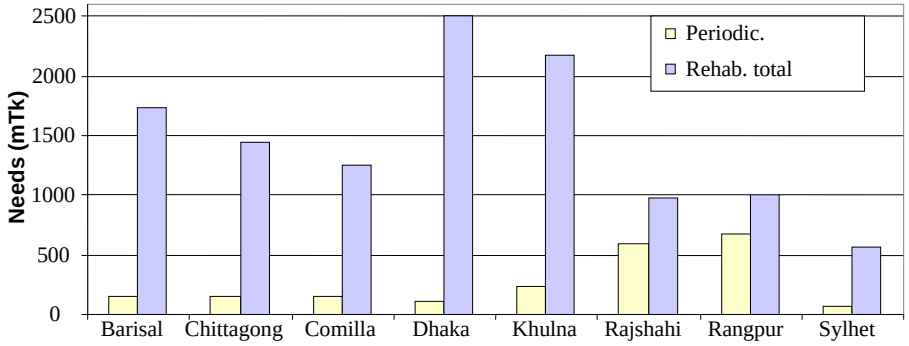

Figure 9: Zone wise capital needs of Zilla Roads for 2008-09 in Million Taka (excluding ongoing projects)

5.2 Pavement Strengthening

The 2007-08 Needs Report included an evaluation of the requirements for strengthening of national roads, based on RMMS deflection data. This was intended to highlight the issue of inherent weakness of many roads in Bangladesh. Table 15 shows that 706 km require strengthening overlay and total costs are given. The Asphalt Institute Rehabilitation Design Chart (Asphalt Institute, 1993) was used for overlay thickness.

Table 15: Results of the Strengthening Overlay Design Analysis

Type of Roads	Analyzed Length (km)	Required strengthening overlay (km)	Total HDM-4 demand (mTk)	Total strengthening costs (mTk)	Additional demand (mTk)
Corridor roads	455	454	2,037	3,795	1,758
Other National Highways	268	252	982	1,503	520
Total	**723**	**706**	**3,019**	**5,298**	**2,278**

5.3 Overall Needs

The five-year plan should be based on the "All Roads" HDM Output. Costs of strengthening overlays have been distributed over the first three years as shown in Table 16 below. Appropriate adjustment should be made to these figures for the costs of deferring maintenance. An allowance of 15% has been considered for increase in the total five-year costs for rehabilitation and full reconstruction has been made.

Table 16: Overall Maintenance Needs by category (million Taka)

Work Type	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Routine Maintenance	967	1,483	1,581	1,686	1,754	7,471
Periodic Maintenance	5,319	4,599	4,817	6,234	7,368	28,337
Partial Reconstruction	7,286	9,644	10,525	10,067	8,237	45,760
Full Reconstruction	3,632	3,621	3,003	2,606	2,155	15,017
Strengthening	759	820	886	0	0	2,465
Total	**17,963**	**20,167**	**20,812**	**20,593**	**19,514**	**99,050**

서식 있는 표

~~1.1~~ The Road Master Plan (RMP) makes a strong case for separating the assessment of Zilla Roads from that of National and Regional Roads. It can be seen from Tables 17 and 18 that the needs of Zilla Roads are predominantly rehabilitation and reconstruction, hence the proposal in RMP for a "Zilla Road Recovery Programme". In the past two years, no Zilla roads have featured in the Periodic Maintenance Programme (PMP) because the prioritisation using NPV/C favours more heavily trafficked roads. It is therefore important that a separate prioritisation process is adopted for Zilla Roads.

서식 있음: 표준

Table 17: Overall Maintenance Needs by category – National and Regional Roads (million Taka)

Work Type	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Routine Maintenance	421	583	606	636	643	2,889
Periodic Maintenance	3,943	3,329	3,532	4,571	5,402	20,778
Partial Reconstruction	2,046	2,582	2,877	2,752	2,251	12,507
Full Reconstruction	1,263	1,229	1,060	954	795	5,303
Strengthening	759	820	886	0	0	2,465
Total	**8,432**	**8,543**	**8,961**	**8,913**	**9,091**	**43,942**

서식 있는 표

서식 있음: 글꼴 색: 검정

Table 18: Overall Maintenance Needs by category – Zilla Roads (million Taka)

Work Type	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Routine Maintenance	546	900	975	1,051	1,111	4,581
Periodic Maintenance	1,375	1,270	1,285	1,663	1,965	7,558
Partial Reconstruction	5,240	7,063	7,648	7,316	5,985	33,252
Full Reconstruction	2,369	2,392	1,943	1,651	1,360	9,714
Total	**9,530**	**11,625**	**11,851**	**11,681**	**10,421**	**55,105**

서식 있는 표

The results of the HDM analysis show that, in the first five years, the budget demand for Zilla Roads is higher than that for National and Regional Roads. The overall figures translate into a need to invest in Zilla Roads over the next five years at a cost of Tk 1,030/m^2 of pavement area compared with the equivalent of Tk 920/m^2 for National and Regional Roads. It is therefore strongly recommended that separate budget provision is made for Zilla Roads for the next five years.

~~1.2~~ 6.0 RECOMMENDATIONS FOR IMMEDIATE NEEDS

서식 있음: REAAAmainHeading

Table 19 shows the total budget required for maintenance and rehabilitation of RHD Roads for the year 2008 - 2009. This figure assumes that there are no budget constraints.

Table 19: Immediate Maintenance Needs 2008-2009 (million Taka)

Routine Maintenance	Periodic Maintenance	Partial Reconstruction	Full Reconstruction	Total
967	9,449	11,833	5,979	28,228

~~1.3~~

6.1 Five-Year Needs

The above figures represent an ideal budget to carry out all necessary maintenance and rehabilitation in one year. Clearly this level of budgeting is impractical and therefore an average value, adjusted to allow for the increased cost of deferring maintenance is proposed, as shown in Table 20.

Table 20: Overall Maintenance Needs 2008-2013 (million Taka)

Year	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Total	17,963	20,167	20,812	20,593	19,514	99,049

~~1.4~~

7.0 SOME CHALLENGES OF ROAD ASSET MANAGEMENT

Socio-economic factors are extremely important in prioritising maintenance treatments, especially for Zilla (District) roads in Bangladesh. Most of the Zilla roads were not initially constructed with proper treatment of sub-soil / sub-grade since the volume of traffic was not very high. However, as traffic is growing in these roads, government has taken initiatives to develop these potential roads in phases.

During the next five years, Zilla Roads will require more funding than National and Regional Roads while the prioritisation of projects using NPV/C favours the more highly trafficked roads. The Road Master Plan outlines an alternative approach to the evaluation of Zilla Roads needs that is related to road function, condition and local socio-economic need.

Some roads are not performing well with preventive maintenance overlay, as many roads are structurally weak. these roads require a strengthening overlay to overcome structural deficiency. It should also be mentioned here that overloading factors were not analysed in this year. The Road Master Plan estimated that overloading costs an additional 3,000 million taka per year in additional maintenance costs. It is essential that the axle load control programme as outlined in the Road Master Plan is implemented. Unpaved roads have to be paved in the next 5-years, which is accepted road sector policy as outlined in the Road Master Plan (RHD, 2007).

8.0 CONCLUSIONS

The general findings of the analysis are:

- The condition of RHD roads has deteriorated, continuing the trend seen in previous years.
- Most of the Zilla roads require either partial reconstruction or full reconstruction (see Appendix-D). the Zilla Road Recovery Plan set out in the Road Master Plan needs to be urgently implemented.
- Strengthening overlays are required for the National highways to ensure that pavements will withstand design traffic loads. It was observed that 707 km require strengthening overlay.
- Field responses reveal that HDM-4 results are acceptable.

REFERENCE

- The Maintenance and Rehabilitation Needs Report for 2008-2009 for RHD Paved Roads published by Roads and Highways Department of Bangladesh.

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서식 있음: 글꼴: 굵게, 글꼴 색: 검정
서식 있음: 가운데
서식 있음: 표준
서식 있는 표
서식 있음: 글꼴: (영어) Arial, 굵게, 글꼴 색: 검정
서식 있음: 가운데
서식 있음: 표준